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BANKING AND HIGH-TECH EXPORTS: PREMISES FOR LONG-TERM ADDED VALUE CREATION?

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Abstract

The article addresses the issue of identifying some determinants regarding the growth of high-tech exports at the European level, as a starting point in the creation of long-term added value. In this study, the relationship between the endogenous variable high-tech exports and the exogenous variables: Research and Development Expenditure, Gross Capital Formation, Gross Domestic Product, Articles in scientific and technical journals, and Domestic credit to the private sector were examined. In the empirical study, econometric data analysis was used (by applying the FGLS model). A sample consisting of the 27 countries of the European Union was selected to identify the associations between the variables. The identified results revealed a positive impact of both Research and Development Expenditure and Gross Domestic Product on high-tech exports. Another statistically significant factor identified is Domestic credit to the private sector, but with reverse causality, with several countries with more domestic debt being less likely to perform well in the field.

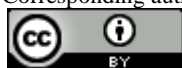
Keywords: high-tech exports, value added, R&D expenditure, bank financing, Gross Domestic Product, innovations, European Union.

JEL Classification: F10, O32, O52

Introduction

In the new multipolar world, as the global economy undergoes transformations, international trade remains an important driver of economic growth. In this context, the high-tech exports acquire an increasingly important share in the international trade, due to

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the benefits they offer, including, from the perspective of long-term added value, as the high-tech industries are more productive and sophisticated, the possibility of exporting more high-tech products is directly associated with a nation's competitiveness. High-tech exports include products that require significant resources and research for development and production, such as aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery (World Bank, 2023). As a result, we are witnessing strategic resettlement, both from a commercial and technological point of view, which adds to the challenges facing investors and also creates parallel potential for portfolio diversification for investments. The US seeks to protect its intellectual capital and domestic production of critical technologies, acting through restrictions on the export of US technology to certain Chinese companies. At the same time, China is likely to accelerate its drive to become more technologically independent, with innovation activity within the country increasingly integrated into global corporate efforts. All member states of the European Union (EU) have trade links with China, but are characterised by an imbalance at the EU level, which has doubled in the last decade, a trade deficit of EUR 249 billion in 2021, the largest in recent years.

One of the main problems of the European Union is the lack of its own high-tech products to be distributed worldwide (EUROSTAT, 2023). At the same time, the exports of the European high-tech industry have increased considerably, rising from EUR 235 billion in 2010 to EUR 311 billion in 2020, but there are only two major European players in this industry: Germany and France. In 2018, Germany had a high-tech sector turnover of EUR 205 billion, while France recorded EUR 177 billion. The European electronics market is dominated by China, the world's largest producer.

In 2022, the high-tech exports of the European Union (EHT) to non-EU countries amounted to EUR 446 billion (an increase of +16%, compared to 2021), with the United States being the main trading partner (with a share of 26%, that is, EUR 118 billion), followed by China (12%, that is, EUR 53 billion) and the United Kingdom (9%, that is, EUR 42 billion), as shown in Figure no. 1. EU exports of high-tech products by product group. The most important category of high-tech products exported to non-EU countries was pharmaceuticals, with a value of EUR 145 billion (EUROSTAT, 2022).

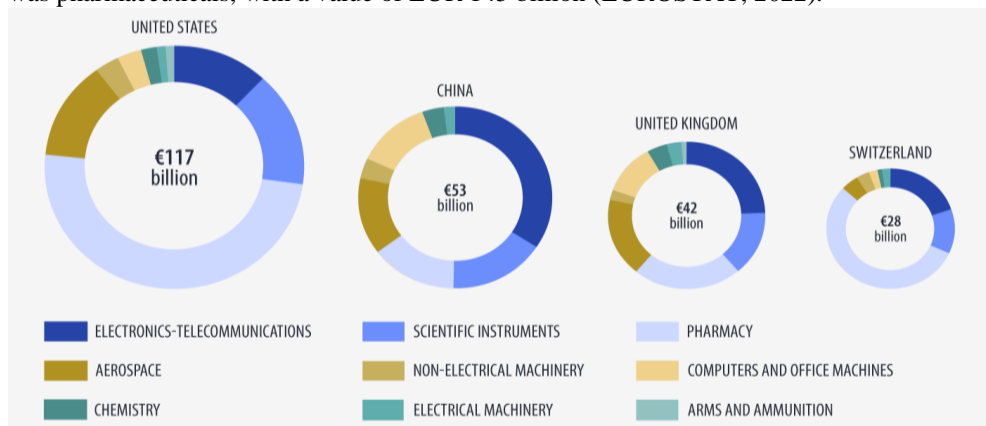


Figure no. 1. EU exports of high-tech products by products group, 2022
(€ billion and percentage shares %)

Source: EUROSTAT, 2023

At the European level, the western and northern European countries manage to be competitive, investing in research and achieving performance in the field of innovation, specialising in technology-intensive activities that generate benefits at the level of the respective economies. For their part, Central and Eastern European countries, tributary to other development models, are specialised in industrial production of a lower technological level, being intensive in natural resources and labour. Consequently, there are significant differences between the commercial performances of these countries, some historical, coming from different development models with roots in the communist period, and others are of recent date, generated, by the post-COVID crisis context and the Russia-Ukraine war.

High-tech products are defined as products that incorporate research and development (R&D) and contribute to the creation of long-term added value. In this research, the authors considered the intensity of R&D and innovation as predictive factors for high-technology export. Investments and internal credit also play an essential role in determining the trade patterns of European countries. Several companies that have an approach considered traditional, use financial resources from the banking sector (in the form of banking loans) or from shareholders (equity financing) to finance their technological investments, while other companies, orientated to research and development (R&D) and innovation, rely more on funds raised from the capital markets to support their export efforts and investments in technology. The degree of development and complexity of the banking sector, its ability to finance exports and to attract non-reimbursable funds, the degree of banking, are the elements that support the high-tech exports. Other elements of support for high-tech exports are innovation and creativity (generically represented in our study by the number of articles published in scientific and technical journals), R&D activity (reflected by the expenses incurred with this activity), as well as the investments made (expressed by the indicators Gross Capital Formation and Domestic credit to the private sector), represent premises for increasing the production of high-tech goods, to create long-term added value.

In this research, the authors aimed to provide answers to the following question: *Which of the indicators analysed at the level of the 27 component economies of the European Union (Research and Development expenditure, Gross Capital Formation, GDP, articles in scientific and technical journals, and, respectively, domestic credit to the private sector), for the period 2007-2021, have a positive, a determining impact, or do they significantly influence the evolution of the high-tech exports?* The period 2007-2021 is relevant for the analysis, as it was marked by multiple crises, such as: the financial crisis of 2008, the sovereign debt crisis in Greece, the pandemic crisis that started in 2020, the energy crisis, the crisis of production chains, and distribution. The context of multiple crises gave the start to profound changes in the European social and economic environment, reflected by technological transformations, increased production and exports of vaccines, computers, green energy, changes in the lifestyles, and consumption of the European population. These changes will be felt in the future, in the configuration of competitive advantages at the EU level. From the perspective of the gaps regarding exports of high-tech goods at the level of the European Union, Western European countries still maintain a considerable advance over Eastern and Central European countries, thus raising new research topics, both in future academic research endeavours and in the concerns of political decision-makers. Looking at the impact of Gross Capital Formation and GDP indicators, it can be emphasised that the influence of these two indicators leads to structural changes in GDP and exports. From a scientific perspective, the following questions remain: Has Domestic credit for the private sector been significantly oriented towards technology? Is the

expansion of financial resources available to companies in the form of bank credit, traditional bank financing, and equity financing from stock markets sufficient? Or is the intervention of the state necessary through its own mechanisms? Is it necessary to technologically reindustrialise the countries of eastern and central Europe based on an established plan that provides for concrete implementation milestones and, above all, to stipulate the objectives proposed to be achieved? These topics form the basis for future research topics.

After the introductory part, the article is structured into four other sections. The review of the specialised literature is highlighted, followed by the presentation of the methodology and the empirical research. The results obtained and their discussions are presented in the third section, followed by the research conclusions.

1. Review of the literature

The literature addressing concepts such as *research and development expenditures*, *gross capital formation*, *GDP*, *the number of scientific articles*, and *domestic credit to the private sector* and their impact on exports of high-tech goods is constantly increasing. According to World Bank indicators, high-tech *exports* are products that involve significant research work, such as computers, pharmaceuticals, scientific instruments, electric cars, electronics consumers, software, electronic transport products, military and civil aerospace, and the possession of high-tech sectors and skills *in the export of high-tech products* is considered as one of the important factors for an economy (Gökmen and Turen, 2013), in terms of the high added value that these products encompass.

Regarding *research and development (R&D) expenditure*, in the paper published in 1967, the authors Gruber, Mehta and Vernon present the research result, identifying a strong correlation between *research and development expenditure* and export performance. Research and development expenditure is considered as an indicator of the temporary comparative advantage that firms and nations acquire in terms of introducing new products and production processes. Braunerhjelm and Thulin (2008) show that R&D investment is a key determinant of high-tech exports among the OECD (Organisation for Economic Cooperation and Development). Sandu and Ciocanel (2014), studying the impact of research, development, and innovation on high-tech export, concluded that the results confirm a positive correlation between the total R&D expenditure and the level of high-tech exports. According to Karpińska (2021), in the context in which the COVID-19 pandemic forced many companies to reduce their investment budgets in terms of R&D and innovation activities, precisely those companies that implemented innovative solutions before the onset of the pandemic proved to be more resilient in the context of the crisis.

Gross Capital Formation (GCF) consists of expenses to replenish fixed assets of the economy. These include land improvements, plant and equipment purchases, and the construction of roads, railways, including schools, offices, hospitals, private residential housing and commercial and industrial buildings, plus net changes in the level of inventories of goods held by firms to meet temporary fluctuations or unexpected disruptions in production or sales, and "work in progress" (according to World Bank indicators). Capital formation can be used to promote Research and Development activity and determine a country's ability to produce, the latter having an impact on economic growth. Consequently, insufficient capital formation is a significant limitation to

sustainable economic growth (Kalaitzi, 2013; Dinu and Bunea, 2019). The results of the research on the economic growth and implicitly, the added value in the long term confirm the importance for the growth of the R&D activity, the macroeconomic level, and commercial openness. There is consensus on the positive effects that Gross Fixed Capital Formation (such as infrastructure investment) has on the economies of advanced countries at the macroeconomic level (Barro, 1991; Bassanini and Scarpetta, 2003; Dinu and Bunea, 2015). Gross capital formation is also directly related to the development and sophistication of the banking sector, facilitating access to the financial resources available to companies that invest in high-technologies through banking credit related to traditional bank financing or through equity from the stock markets, which is likely to lead to substantial increases in international exports, and implicitly, high-tech exports.

Exports of high-tech goods are considered an important element for a country's economic growth, contributing significantly to that country's *GDP* production. Many researchers have analysed the impact of GDP on economic growth. For example, Crespo Cuaresma and Worz (2005), over the period 1981-1997, analysed the impact of high-technology exports on productivity for 45 countries. According to the study, high-tech exports have a positive impact on economic growth, while low-tech exports have a negative impact. According to the findings, exports of high-tech products lead to increased productivity between domestic and foreign competition. Likewise, other authors (Falk, 2007; Yoo, 2008) have concluded that both R&D intensity and high-tech exports are significantly positively related to GDP achievement. Gani (2009) analyses whether high-tech exports drive economic growth in countries with higher technological achievements, and the results of the study show that high-tech exports have a strong and positive impact on economic growth per capita, but to benefit from technology, technological capabilities should be developed in the areas of technology creation, technological improvement, and product development.

Based on the specialised literature, the number of patent applications - as a concrete result of *articles published in scientific and technical journals* - has a significant impact on the export of high-technology. From this perspective, certain researchers (Salmon and Shaver, 2005) associate exporting with innovation activity, as exporters are more likely to access diverse knowledge about competing products and customer preferences through customer feedback and external competitors, which facilitates innovation. From the analysis of the relationship between R&D expenditure, patent applications, openness, and high-tech exports between the 2001-2011 periods, the analysis carried out with the FMOLS panel (Fully Modified Ordinary Least Squares Method) and the panel dols (Dynamic Ordinary Least Squares Method) of the BRICS countries (group consisting of Brazil, Russia, India, China, and South Africa), led to the conclusion that R&D spending positively affects high-tech exports in the long term, but the coefficient of patent application was not significant (Kizilkaya, Ay and Sofuoglu, 2016). Other authors, Kabaklarli, Duran and Üçler (2017) identified in their study that patent applications have a positive impact on high-tech exports, 1% increase in patent applications generates a 3.47% increase in high-tech exports. From another perspective, the innovation activity carried out within universities regarding small and medium-sized companies should also be highlighted, thus determining a constant increase in the development of high-technologies (Keeble and Wilkinson, 2000).

The last exogenous variable considered in the article, *Domestic credit to the private sector*, is assimilated to the overall financial development of a country and the banking sector in that country, a large volume of domestic capital attracting foreign investors, as foreign

direct investment and domestic capital are complementary in the production process (Obwona, 2001; Naudé and Krugell, 2007). In the economic literature, the banking sector considered together with bank lending channelled to technology and high-tech exports remains underexplored, although it plays a prominent role in economic growth and prosperity. Furthermore, in the study, we add value to the existing literature on high-tech exports by including and analysing a new variable, Domestic credit to the private sector, a variable assimilated to financing from the banking sector.

2. Data and Methodology

The research sample includes information collected from 27 countries of the European Union, assessed for 15 years, in the 2007–2021 period. Thus, the total sample size consists of 405 observations. However, as shown in the description of the variables, at the date of this research, for some of these variables, the data were only available until 2020 (*Table no. 1. Description of variables*). Consequently, when these variables are used, the sample size is reduced to 378 observations. The data series were taken from the World Bank database. Considering the high heterogeneity of the data within the European Union countries and over time, the variables were transformed using the natural logarithm.

Table no. 1. Description of variables

Endogenous variables	Exogenous variables	Time span
1. High-technology exports (<i>HTE</i>) 2007-2021	1. Research and development expenditure (<i>R&D</i>)	2007-2020
	2. Gross capital formation (<i>GCF</i>)	2007-2021
	3. Gross Domestic Product (<i>GDP</i>)	2007-2021
	4. Scientific and technical journal articles (<i>Articles</i>)	2007-2020
	5. Domestic credit to the private sector (<i>Credit</i>)	2007-2020

Source: own construction

The main objective of this research is to study the evolution of high-tech exports and the impact of determinants at the level of countries of the European Union. Based on studies from the scientific literature, the following research hypotheses have been identified:

H1: High-technology exports are impacted by the economic development and have the same spatial features as the later. Several studies have shown that countries with a more developed economy have higher high-tech exports, while the least developed countries are found to have lower value-added exports.

H2: High-tech exports are directly affected by the level of research and development. High-tech products and services incorporate innovation as they are, actually, the final result of research and development processes. Consequently, countries with a higher share of the R&D budget in their GDP are more likely to have higher levels of high-technology exports.

H3: High-technology exports are directly determined by the level of investments. As in the case of H2, we consider that investments are made to support innovation and production, increase production capacities, so, consequently, they should also have a direct positive impact on high-tech exports.

H4: There is a direct causality between academic research and high-technology exports at the EU level. As we have already explained, R&D is expected to positively impact high-tech exports. But most of the research activities in any country happen within the academic environment, conducted by university staff. Academic research output may be accounted

for in many ways. Among the criteria used to determine academic performance in research is the number and indexing of articles published in scientific and technical journal articles. Therefore, in this research, the authors use the number of published articles per country and assume that the higher this number, the higher the high-tech exports.

In developing this research, the authors conducted a descriptive assessment. The descriptive statistics of the panel for the recorded variables are presented in *Table no. 2*. According to the data presented, it is noted that in all cases the deviation between the standards is large, indicating significant effects. At the same time, the authors also evaluated the spatial distribution of the variables using maps.

Table no. 2. Panel descriptive statistics

Variable		Mean	Std. Dev.	Min	Max
HTE	overall	22.56	1.80	17.82	26.10
	between		1.81	18.20	25.99
	within		0.29	21.40	23.59
R&D	overall	21.66	1.91	17.48	25.54
	between		1.93	18.00	25.35
	within		0.22	20.83	22.32
GCF	overall	24.51	1.51	21.19	27.62
	between		1.52	21.55	27.35
	within		0.22	23.80	25.54
GDP	overall	26.01	1.50	22.64	29.08
	between		1.52	23.12	28.92
	within		0.14	25.52	26.56
Articles	overall	8.89	1.53	4.43	11.59
	between		1.54	5.41	11.52
	within		0.22	7.90	9.53
Credit	overall	25.79	1.65	22.70	28.92
	between		1.68	23.05	28.76
	within		0.20	24.98	26.48

Source: own calculations in STATA 16

In the second phase, the properties in the panel dataset were tested for all-time series. The most important features depicted are significant autocorrelation and cross-section dependence. In the case of serial correlation, the Wooldridge test returned a value of 92.02, with a p-value of 0.000. For the cross-section dependence test, the Pesaran test returned p-values of 0.000 for all variables, pointing out the need for an estimation method that treats cross-section dependence. Table no. 3 synthesises the results of the Pesaran test. Additionally, slope coefficients proved to be heterogeneous, p-values for both delta and adjusted delta are 0.000. Considering all these findings related to the properties of the dataset, we finally opted for the Feasible Generalized Least Squares (FGLS) model, with heteroskedasticity and 1st order serial correlation.

The general model is described by eq. (1):

$$HTE_{it} = \alpha + \sum_{k=1}^m \beta_k X_{kit} + \varepsilon_{it} \quad (1)$$

where: α is the constant term, X_{kit} is each of the factor variables, β_k is the regression coefficient for each of the factor variables and ε_{it} stands for all the effects of the panel that may appear, i stands for the country and t for time.

Table no. 3. Results of the cross-section dependence test

Variable	CD-test	p-value	corr	abs(corr)
HTE	8.48	0.000	0.137	0.499
R&D	26.76	0.000	0.423	0.521
GCF	29.98	0.000	0.470	0.533
GDP	33.42	0.000	0.526	0.589
Articles	43.30	0.000	0.673	0.722
Credit	23.42	0.000	0.371	0.555

Note: The analyses were performed using STATA 16 and Tableau 2022.4.

Source: own calculations in STATA 16

Results and discussion

The descriptive assessment based on maps points out the best and worst performers in the European Union. In terms of time, the general characteristics of the EU members have been preserved. Germany is the best performer in terms of high-tech exports both at the beginning of the analysed period and at the end (*see Figure no. 2. High technology exports in 2007 and 2021*), followed by France and the Netherlands. The opposite side of the ranking is occupied by Central and Eastern European countries such as Bulgaria, Croatia, Cyprus, or the Baltic countries. It is interesting to note that both in 2007 and in 2021 Portugal was an outlier in its group, having high-technology exports below the median. In addition, it should be noted that the situation in Ireland is worsening, from a very good value in 2007, to one of the lowest in 2021. Finland has a similar behaviour, with a value below the median in 2021, but not such an intense depreciation as in the case of Ireland. A similar spatial distribution is observed when considering the average for the analysed period. Such spatial positioning may be explained by several factors. First, the bad performers are almost entirely Central and Eastern European members. These countries have, on the one hand, low R&D budgets. On the other hand, even though these countries have absorbed foreign direct investments, and some of them have very well-developed high-tech sectors, their national economies are characterised by outsourcing. This means that research outputs are not registered in the actual country where they were obtained, but are registered in the country of the mother company. Additionally, a significant part of the output is not considered as export, once again, due to the outsourcing features of that economy or sector. This is, for example, the case of Romania, with a very well-developed IT sector in the area of Cluj-Napoca, but not that there is a significant value of the sector's output from this perspective (Petrovici, Mare and Moldovan, 2021).

But from the map analysis, high-tech exports follow the spatial pattern of the development level of the European Union. That is why the spatial distribution of the member states was also assessed in terms of GDP and in terms of R&D expenditure. The results are presented in *Figure no. 3. Spatial distribution of GDP and R&D expenditures - average values for the analysed period* and confirm assumptions, along with validating the first research hypothesis, H1.

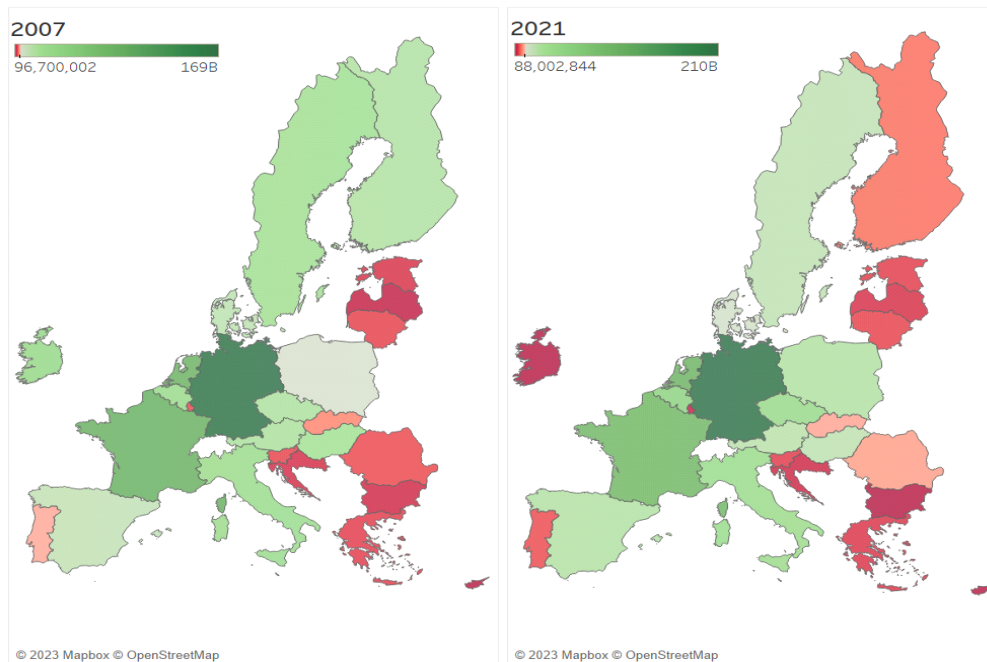


Figure no. 2. High-tech exports in 2007 and 2021

Source: Own construction in Tableau 2022.4

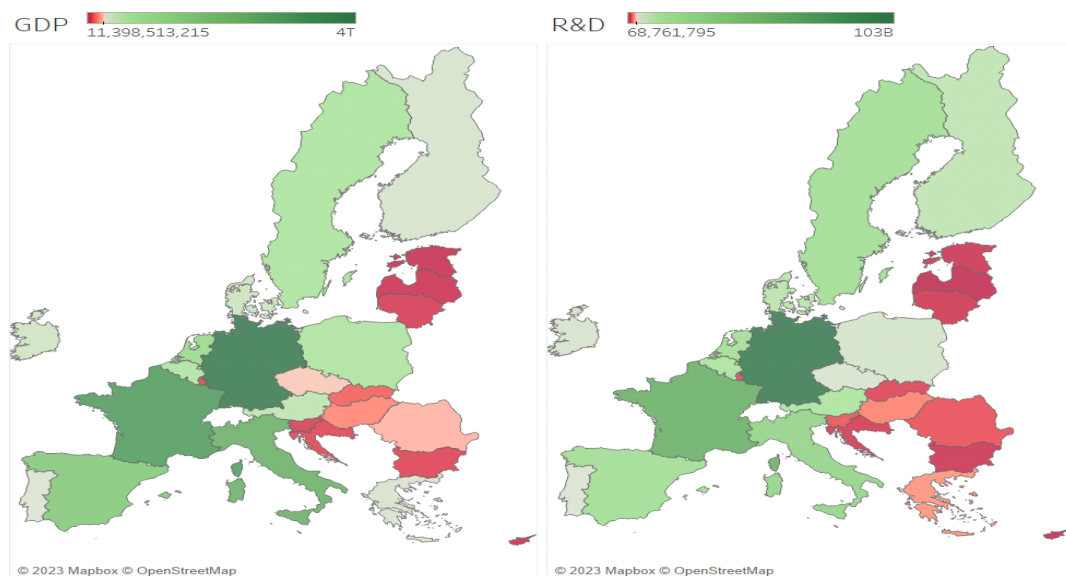


Figure no. 3. Spatial distribution of GDP and R&D expenditure – Average values for the period analysed

Source: Own construction in Tableau 2022.4

The estimation results are presented in *Table no. 4. Panel regression results* show that high-technology exports are significantly and positively dependent on Research and Development activity and GDP, confirming both, H1 and H2. This result is expected, since the more financial resources a country invests in R&D, the higher should be the quality of the output. In this case, the output is measured by a dependent variable, consisting of high-tech exports. Additionally, richer countries can afford to invest more in R&D. As a result, a higher GDP (meaning richer countries) leads to higher amounts of money invested in R&D and, obviously, to a much better high-tech and innovation performance.

Table no. 4. Panel regression results

HTE	Coef.	Std. Err.	z	p-value	Conf. Int.
R&D	0.55	0.07	7.91	0.000	[0.41; 0.69]
GCF	0.04	0.10	0.45	0.653	[-0.15; 0.24]
GDP	0.96	0.18	5.32	0.000	[0.60; 1.31]
Articles	-0.03	0.08	-0.35	0.724	[-0.18; 0.12]
Credit	-0.58	0.09	-6.52	0.000	[-0.76; 0.41]
Const.	-0.15	1.33	-0.11	0.911	[-2.75; 2.45]

Source: own calculations in STATA 16

Another statistically significant factor is domestic credit, but this time with reverse causality. Investments measured through the formation of gross capital do not statistically impact HTE, invalidating H3. This may be because the GCF measures this type of investment globally, without considering whether the actual investment has taken place in high-technology sectors or not. In many cases, capital formation may come from other sources or may imply other investment directions than the actual research and development processes that lead to innovative products and services. Consequently, it may lose its influence, as it is a too broader variable, encompassing all capital formation processes in a national economy, regardless of the level of product complexity or innovation and added value. The orientation of internal credit is decisive to bring added value in the long term. Thus, the significant orientation of domestic credit toward consumption, toward the support of non-productive investments, toward imports, will contribute both to the increase in indebtedness and to the increase in the pressure regarding repayment, in the medium and long term. Directing domestic credit to support production capabilities that integrate technology, accommodate R&D results and technology transfer from research to industry, and that create new production and distribution chains will produce added value in the medium and long term. Investments, internal credit, and mixed financing, through dedicated programs, represent catalysts for the new European economic-industrial design.

Another non-significant variable is the scientific research manifested at the level of a country. This result shows that the fourth assumption, H4, is not validated. One possible reason may be the fact that scientific output is highly correlated with the level of research and development. Furthermore, high-tech exports do not always depend on scientific output. Companies that innovate do not always publish their innovations, but rather patent them and put them directly into production. Additionally, there is a very diverse relationship between the academic and the business environment within the European Union. In many countries, academic research is considered as being too abstract for the business sector, and, instead of cooperating one with the other, their actions diverge. The R&D activity must be adapted to the needs of the respective industry, the research having to be connected to the evolution trends in the respective industry and to the research and

funding programmes of the EU, a significant impact in this sense also having the connection of credit and the banking sector with the environment business and academic.

In terms of perspectives, great opportunities are being created for the Central and Eastern European countries, but to benefit from them, the respective countries must: build innovation capacities, adopt and transpose in economic activity the principles of corporate governance and international cooperation, facilitate technology transfer, increase women's participation in digital sectors, promote debates on the impact of frontier technologies on sustainable development, implement suitable financing mechanisms. From the perspective of innovation, within the European Union, the northern countries: Sweden, Finland, Belgium, and the Netherlands exceed the level recorded by much larger Southern countries, such as Italy or Spain, which shows the source of the perpetuation of productivity gaps. But the acquired knowledge is transmitted through the multinational companies, and its transposition in the production processes is carried out, for reasons of lower labour costs, also in the countries of Central and Eastern Europe. In this context, the development of the competitive advantage is of great importance, with efforts focussing on the achievement of advanced technological factors by considering both the capacity to use the infrastructure, capital resources, and especially the human ones. Consequently, in addition to the exogenous variables considered in the empirical study, special attention must also be paid to human capital. The impact of human capital on technological production processes and implicitly, on high-tech exports, leads to assimilation by the workers of new techniques and methods, the latter improving technical knowledge with direct consequences in stimulating the high-tech exports (Mahmood, Wang and Hassan, 2019). Improving technical skills will favourably influence the efficiency of R&D activities, and these, in turn, will have a favourable effect on human capital (Chou et al., 2019). Directing the financial mechanisms and banking resources toward the creation of added value, in the long term, of those regarding the R&D activity, the creation of new value chains, in the country and abroad, the diversification of suppliers, the development of critical industry in the country or regionally within the EU, the development of sustainable exports, judiciously combined together to achieve efficiency and profitability, lead over time to growth in exports in general and high-tech exports in particular. Furthermore, financial mechanisms can be orientated in such a way as to support complementary imports for the structuring of some export products of the importing country. In order to recover the gaps between the Research and Development sectors at the level of different European countries, we indicate as financing methods the funds from the development banks and the sovereign funds for research resulting from the mobilisation by the EU states, the allocation at the EU level of concessional loans or grants, and instruments, such as the state funds or financing of technology-oriented activities, with co-investment from the respective industries.

In order to recover the differences between the R&D sectors at the level of different European countries, it is necessary to operate some changes in the opportunities offered by the legislation. An important role in covering the investment gaps in the R&D and innovation sectors, as well as the investment gaps related to innovative SMEs, is expected to be played by the strategic investments carried out by the development banks from the various states of the European Union, sovereign funds, private management funds, as well as funds from wealthy families (wealth management). Initiatives started in 2008, at the European level, led to the creation of the European Institute of Innovation and Technology with the aim of helping businesses, educational institutions, and research bodies work together to create an environment favourable to innovation and entrepreneurship in Europe

and to form *dynamic multinational partnerships*, known as communities of knowledge and innovation. An example in this regard is the steps, at the European Union level, regarding the use of green hydrogen as an energy vector for sustainable development and as a solution for balancing the insecurity generated by renewable energy sources. Green hydrogen can be produced easily, can be used in all energy fields, and is the least polluting. *It contributes only to a small extent to the global energy supply, the main reason being the high cost of production. To stimulate green investments, it is planned to launch the European Hydrogen Bank, with an initial budget of EUR 800 million, secured from the European Innovation Fund.* Europe needs to catch up with the US and China in the commercialisation of its AI technologies and access to data sources, as the EU has lagged behind in turning its local advantages into marketable advantages that could strengthen its industrial base of innovation at the European level (Sahin and Barker, 2021). The EU's stated intentions are to achieve technological sovereignty in some critical technological areas, such as quantum computing, artificial intelligence, block chain and critical chip technologies. Europe's "catch-up" stance vis-à-vis the US and China clearly shows that the EU and its member states need to adopt a sophisticated approach to increase their ability to act in the technological field (Morandini, Thum-Thysen and Vandepla, 2020).

The economic and social developments at the European Union level from 2007-2021 prepared the ground for a new paradigm. The general situation in the Central and Eastern European Region has fundamentally changed in the geopolitical context marked by the war in Ukraine. The growing influence of NATO from a military point of view is manifested in parallel with the increase of NATO investments in the region, using various financing and investment channels, including through a dedicated investment fund, such as the NATO Investment Fund. For the 32 countries that make up NATO and that carry out high-tech exports (in the fields of nuclear, cyber, food, sustainable energy, and health), the concept of *exports to friends* will continue to be a protection tactic against the political disruptions and climate changes, moving the production out of riskier environments and into "friendlier" regions.

Conclusions

This research has as main objective the analysis of the determining factors that contribute to the achievement of high-tech exports and implicitly to the achievement of added value at the level of the respective economies that generate this type of exports. The results obtained from the empirical study are in line with the results from the specialised literature, identifying themselves as influencing factors on high-tech exports: Research and development expenditures and, respectively, the Gross Domestic Product. Another factor identified, statistically significant, is Domestic credit to the private sector, but with a reverse causality. Countries with more domestic debt are less likely to perform well in high-skill areas. Internal credit to the private sector must be related with the support of companies that produce technologies and thus generate long-term added value in the economy, with the need for co-financing through internal credit of some non-refundable programs, of some research-development programs to support the debt mix (internal credit), investors participation (equity), and non-refundable funds (government programs).

The convergence of financing sources, production capacities based on high-tech input, high technology exports, represents the strategic anchor for the competitiveness of the European economy and for the synergistic use of human, financial, and technological capital resources.

At the European level, the leading countries in the top of high-tech exports are Germany and France, these countries benefiting in the past from the advantages brought by investments with non-reimbursable funds, to create added economic value in the long term. In the future, at European level, amid efforts to catch up with the US and China, the focus should be on promoting a culture of innovation where digital companies and start-ups can thrive, as well as increasing technological capabilities, mitigating the excessive dependence on third countries, or competing powers.

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